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ABSTRACT

The effect of three levels of short-term memory (STM) and four learning modes (control, chunking organizational strategy, programmed instruction, and adjunct questions) on prose learning and recall was studied. The participants in this study were educational psychology students at Towson State College in Maryland. Significant STM and learning mode effects on immediate and delayed posttests suggested two conclusions: (1) that low STM subjects are generally handicapped in comparison to high STM subjects, and (2) that prose materials used without modification may not lead to optimum performance. Substantial and significant correlations between STM and test scores on the delayed posttest suggested further research uses for the STM test. (Author/LL)

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Short-Term Memory Effects in Four Learning Modes

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SUMMARY

Short-Term Memory Effects in Four Learning Modes

Short-term memory (STM) plays a key role in human memory. In fact, the overall memory system has been described in terms of the flow of information into and out of STM (Atkinson & Shiffrin, 1971). Accepting the information processing theory of memory, two factors assume paramount importance: the limitations placed upon our ability to process information by STM (7 ± 2, Miller, 1956) and the influence upon retention by various learning modes (for a summary, see Kumar, 1971). The purpose of this study was to examine the relationship between STM limitations and different learning modes.

The first factor, STM limitations, clearly restricts the quantity of information which a subject can process at one time before rehearsals become necessary. Consequently, a high STM subject may have a distinct advantage over a low STM subject (Furukawa, 1970). However, the relationship between the quantity of information presented before responses are required and STM capacity may be a curvilinear one. For example, Furukawa found that the performances of both high and low STM subjects were best when the number of Hawaiian words to be learned was at or near the subject's STM capacity, with depressed performances with too few or too many chunks in relationship to STM capacity. It appears, therefore, that optimal learning can occur when the quantity of information is equated with a subject's STM capacity. To capitalize on this finding, two of the learning modes used in

this study, programmed instruction and chunking, were specifically prepared to match information load with STM capacity of the average STM subject.

The second factor, learning modes, can be used to improve learning performance. A number of learning modes merited consideration: adjunct questions (Bruning, 1968; Frase, 1969; Frase & Silberger, 1968; Rothkopf & Bisbicos, 1967), advance organizers (Ausubel, 1968), mnemonic devices (Bower, 1970; DiVesta & Sunshine, 1974), programmed instruction (Furukawa, 1970), and organizational strategies (Cohen, 1973; Friedman & Grietzer, 1972). From among these learning modes, three were selected for comparison. These three were adjunct questions, programmed instruction, and organizational strategy. The selections were based on the fact that the adjunct question studies and the organizational strategy studies did not consider STM differences as a variable. The programmed instruction study, on the other hand, did consider STM but did not compare that mode with other learning modes. The primary purpose of this study, then, was to examine the effects of STM differences in these three learning modes and a control mode.

Method

Subjects

All subjects were educational psychology students at Towson State College.

Procedure

Subjects were administered a STM test consisting of two sets of 20 adjective-noun combinations (Furukawa, 1970). One-half

point was given for each correctly recalled word, with the average of the sum of the two scores becoming a subject's STM score. Based on STM scores, subjects were assigned to high, middle, and low STM groups and randomly assigned to one of four learning modes. The learning task was Hamachek's (1969) article on teacher characteristics. The article was presented in the following modes: (a) control, the article without modification; (b) chunking, the article accompanied by a study outline listing seven section headings and seven key words under each section, with each section being studied separately and organized into a larger unit; (c) programmed instruction, the article segmented into sections followed by seven completion questions, followed by seven answers which were identical to the key words given to the chunking group; (d) adjunct questions, the article accompanied by a list of questions worded to elicit the same key words given in the study outline.

The learning tasks were studied for 45 minutes, with a 10-minute test period to answer a 28-question completion test. The same test was re-administered one week later as a delayed posttest.

Results

All means and standard deviations obtained on immediate posttest (IPT) and delayed posttest (DPT) for three levels of STM across four learning modes are given in Appendix 1. These tests were analyzed separately. There was a significant main effect for learning modes on the IPT, F (3/108) = 5.75, $P < .01$, and on the DPT, F (3/108) = 3.63, $P < .025$. On both tests, further analyses using the Dunnett showed that only the programmed

instruction learning mode was superior, at least at the .05 level, to that of the control group.

The STM effect was also significant on the IPT, F (2/108) = 9.02, $P < .001$, and on the DPT, F (2/108) = 10.85, $P < .001$. Tukey comparisons of the IPT results showed that high STM subjects were superior ($P < .05$) to both middle and low STM subjects, but the middle STM subjects were not significantly better than the low STM subjects. On the DPT, however, both high and middle STM subjects were found to be superior ($P < .05$) to the low, but now there was no significant difference between the high and middle STM subjects.

There were no significant interactions on both analyses of variance.

The correlations between STM, IPT and STM, DPT scores were as depicted in Appendix 2. All correlations except those on the control and adjunct question conditions of the IPT were significant. None of the comparisons, between tests or learning modes, was significantly different.

Proportions of original learning retained from IPT to DPT are given in Appendix 3. An analysis of variance revealed two marginally significant effects: for STM, F (2/108) = 2.91, $P < .10$, and for interaction, F (6/108) = 1.98, $P < .10$. Both trends are reported because the STM effect suggests a differential retention rate for the three STM levels and the interaction suggests that the programmed instruction mode may not be the best for low STM subjects.

Conclusions

Three conclusions appear to be warranted by the data: One, programmed instruction is superior to a control mode, under the

conditions which prevailed in this study, but that mode may not be the best for the low STM subjects. Two, the low STM subjects appear to be handicapped on both immediate and delayed posttests, by significant differences in performance scores and two trends: (1) the correlations of the scores with STM, and (2) the proportion of original learning retained from IPT to DPT. Three, the STM test appears to have substantial predictive validty, at least under the conditions described.

Due to the failure of the data to show any one of the learning modes to be superior for all levels of STM, and the trends evident in the data, two further studies are suggested. The correlations between STM and performance scores increased on all but one learning mode from IPT to DPT. The opposite trend appeared for only the chunking mode. This is a possible indication that chunking may be on the verge of achieving the goal of building larger and larger chunks. Hypothetically, if one massive chunk can be created, STM differences should become an irrelevant variable. None of the other learning modes appear to be suitable for use in achieving such an end. The effectiveness of the chunking mode should be studied with subjects being given sufficient time to allow self-paced learning. The second study should consider an alternative learning mode, a mode which combines the best features of programmed instruction and chunking.

Appendix 1

Means and Standard Deviations for Immediate and Delayed Posttests

		Control		CSO		PI		AQ	
STM		I	D	I	D	I	D	I	D
H	M:	11.91	11.65	16.45	12.00	18.95	16.10	13.35	11.25
	SD:	5.18	4.37	3.56	4.94	3.98	5.14	5.16	4.23
M	M:	9.95	10.10	11.55	10.40	16.60	14.85	12.20	10.85
	SD:	4.28	3.56	4.22	3.86	6.62	6.06	4.10	3.21
L	M:	9.85	7.50	10.60	8.50	13.50	8.15	11.45	9.60
	SD:	3.03	3.51	5.81	5.07	6.90	4.77	2.00	3.60

Legend:

CSO: Chunking Study Outline

PI: Programmed Instruction

AQ: Adjunct Questions

M: Mean

SD: Standard Deviation

H: High

M: Middle

L: Low

Appendix 2

Correlations

Test	Control	CSO	PI	AQ
Immediate	.30	.53**	.50**	.32
Delayed	.47**	.44*	.53**	.40*

* $\underline{P} < .05$

** $\underline{P} < .01$

Appendix 3

Proportion Retained from Immediate to Delayed Posttest

STM	Control	CSO	PI	AQ
High	.98	.73	.85	.84
Middle	1.02	.90	.89	.89
Low	.76	.80	.60	.84